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Investigation into the Cases of Yellow Fever in Koundara and Kouroussa, Guinea, January 2021

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Abstract

Introduction: *Guinea is among a group of endemic countries at high risk of yellow fever outbreaks. From 2000 to 2019, the country recorded eight yellow fever epidemics, affecting 1,143 people and resulting in 332 deaths. On January 14, 2020, the National Health Security Agency was alerted by the Conakry Viral Hemorrhagic Fever Laboratory to four positive IgM cases of yellow fever, including three cases in Koundara and one in Kouroussa. Following this alert, an investigation was launched.*

Equipment and Methods: *A descriptive cross-sectional study was conducted in the Koundara and Kouroussa health districts from January 16 to 20, 2021. All confirmed cases (confirmed by laboratory or clinical examination) were included. Data on clinical and sociodemographic characteristics, as well as vaccination status, were analyzed using Epi Info 7.2. Proportions were calculated.*

Results: *A total of 46 suspected cases of yellow fever were reported, including 3 probable cases and 14 deaths. Six cases of yellow fever were identified through active case finding in health facilities (including one probable case and two suspected cases) and in the community (3 suspected cases). In Koundara, among the larval breeding sites, 5 out of 13 contained positive Aedes mosquito larvae in the urban commune; 3 out of 56 in Guingan; 1 out of 7 in Kamaby ; and 5 out of 17 in Sareboido. Vaccination coverage in the surveyed localities of Koundara and Kouroussa ranged from 1% to 42%. In contrast, routine vaccination coverage ranged from 41% to 88%.*

***Conclusion**: Our investigation shows that the potential existence of a yellow fever epidemic in the surveyed areas is of an intermediate type and is conditioned by a rural cycle. Vaccination coverage in the survey was 20%, with Recipient and Breteau indices ≥ 20 in Koundara and 42% in Kouroussa, and larval indices were zero.*

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Introduction

Yellow fever is an acute viral hemorrhagic disease transmitted by infected mosquitoes [1-3]. The yellow fever virus is an arbovirus belonging to the genus Flavivirus and is transmitted by certain species of mosquitoes of the genera Aedes and Haemogogus. These species live in different habitats ; some reproduce around houses (domestic), others in the jungle (wild), and still others in both types of habitats (semi-domestic). There are 3 types of transmission cycles: selvatic (in the jungle) ; intermediate (or rural) and urban [3-5].

incubation period in the body lasts from 3 to 6 days. The infection remains asymptomatic in many people, but when symptoms do appear, the most common are fever, myalgia (most notably back pain), headache, loss of appetite, nausea, or vomiting [3,6,7]. In most cases, symptoms resolve within 3 to 4 days. In a small proportion of cases, patients who contract the disease develop severe symptoms, and about half of them die within 7 to 10 days [3,7,8].

Yellow fever epidemics have been on the rise worldwide over the past 20 years. The number of mosquitoes is increasing, as are their habitats and the populations at risk. It is present in tropical and subtropical areas of sub-Saharan Africa and intertropical America where it remains a formidable endemic disease and a constant threat [1,6]. It is endemic throughout the territory or in certain regions of 47 countries, including Africa (34 countries) and Latin America (13 countries) [5]. Modeling based on African data sources made it possible to estimate the burden of disease attributable to this disease in 2013 : there were 84,000 to 170,000 severe cases and 29,000 to 60,000 deaths [9].

Outbreaks were probable in 2016 in South America in 3 countries, Brazil, Colombia and Peru. 41 cases were probable in Brazil with 4 deaths [10]. Between 2004 and 2015, the number of yellow fever outbreaks in Africa declined thanks to the Yellow Fever Eradication Initiative launched in 2006, which vaccinated over 100 million people [1,9]. However, outbreaks occurred as early as 2015 in Angola, the DRC, and Uganda, and in Nigeria in 2017 [8,11]. In 2018, yellow fever outbreaks occurred in Pointe-Noire, Congo, Ethiopia, and especially in Nigeria's Edo State, where an unprecedented epidemic began in September 2018 [1,8,9]. Guinea is among a group of endemic countries at high risk of yellow fever outbreaks [5]. From 2000 to 2019, the country recorded 8 yellow fever epidemics affecting 1,143 people and resulting in 332 deaths. Several regions of Guinea experienced repeated outbreaks over the past decade. In 2017, there were 6 probable cases out of 338 suspected cases, including 6 deaths across the country, particularly in the prefectures of Telimélé , Gaoual, and Boké [12].

In 2020, Guinea reported a total of 133 suspected cases of yellow fever, including 12 deaths [13].
Since the beginning of October 2020, the health districts of Koundara and Kouroussa have reported 24 and 3 suspected cases of yellow fever, respectively [4]. On January 14, 2020, the National Health Security Agency was alerted by the viral hemorrhagic fever laboratory in Conakry of 4 positive cases of yellow fever, including 3 cases in Koundara and 1 case in Kouroussa.

It was following this alert that the National Health Security Agency, in collaboration with its PTFs, planned a thorough investigation around the positive cases of IGM of yellow fever in order to determine the risk of yellow fever in the health districts of Koundara and Kouroussa and possibly put in place preventive and control measures.

Materials and Methods

Study Framework

Located in West Africa , between the 7th and 12th parallels north and the 8th and 15th parallels west, the Republic of Guinea is bordered to the east by Côte d'Ivoire and Mali, to the north by Senegal and Mali, to the northwest by Guinea-Bissau, to the south by Liberia and Sierra Leone, and to the west by the Atlantic Ocean. It has 300 km of coastline and extends 800 km from east to west and 500 km from north to south. Its total area is 245,857 km² [1]. The study areas were those from which the yellow fever cases originated, in the health districts of Koundara and Kouroussa.

Koundara Prefecture

Located in the North of Guinea (12° 29′ N, 13° 18′ W), this prefecture is bordered to the South by the prefecture of Gaoual, to the East by that of Mali, to the West by Guinea-Bissau and to the North by Senegal.

With an area of 5,505 km², it has a population of 138,898 inhabitants, representing a density of 25 inhabitants/km². The main activities are agriculture , livestock farming and trade [14] .

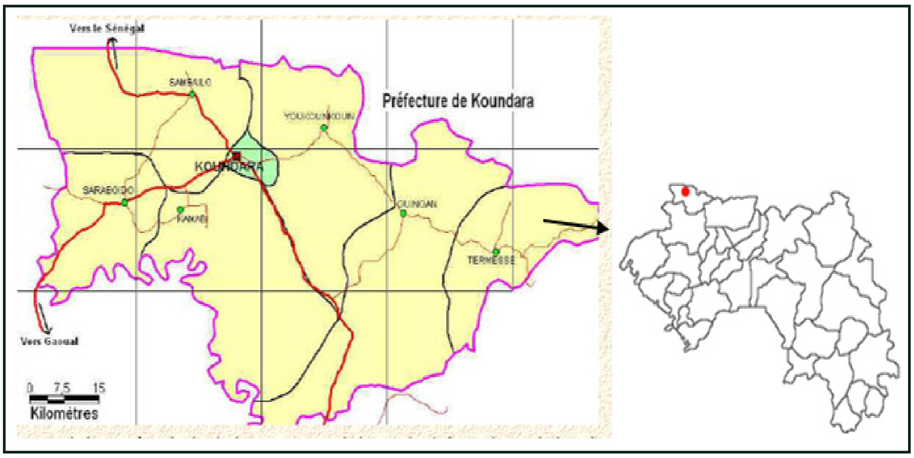

Figure 1: Koundara Prefecture

Kouroussa Prefecture

In the Kankan administrative region, is situated in northeastern Guinea (10°39′00″N 09°53′00″W), between the prefectures of Kankan to the east and Dabola to the west ; Dinguiraye and Siguiri to the north and Kissidougou to the south ; and Faranah to the southwest. It covers an area of 14,050 km² and has a population of 268,630. The eastern part of the prefecture is formed by the Niger River valley, while most of the area is characterized by low hills and dry savanna grasslands or scrubland. Due to the savanna climate, the main activities are subsistence and cash crop farming (rice, peanuts, cotton), livestock herding (by semi-nomadic populations), and artisanal gold mining [15].

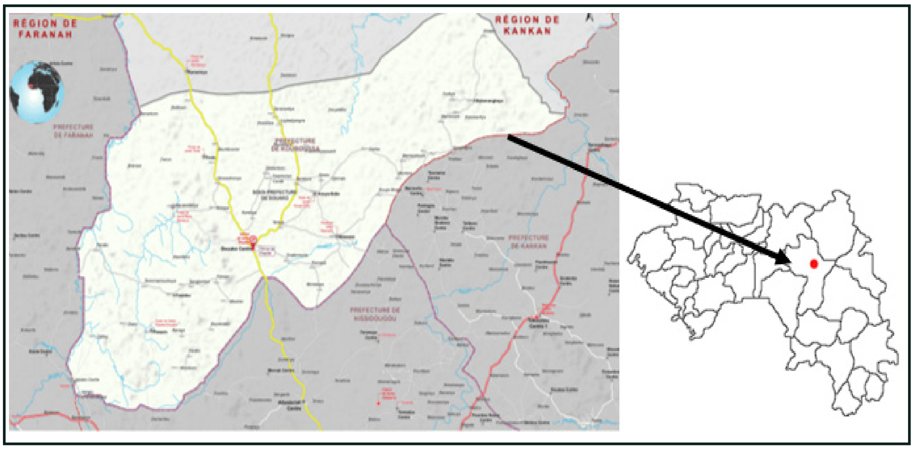

Figure 2: Kouroussa Prefecture

Type and Period of the Study

This was a cross-sectional study aimed at descriptive purposes in the health districts of Koundara and Kouroussa from January 16 to 20, 2021.

Study Population and Sampling

Study Population

these were the populations of localities that had reported probable cases of yellow fever in the health districts of koundara and kouroussa.

Primary Target

The 4 probable cases will constitute the primary target of the study.

Secondary Target

health facility staff, families of probable and suspected cases, their households, their homes, containers containing wastewater, edges and rivers or streams where the community frequents in the health districts of Koundara and Kouroussa.

Operational Definitions

Suspected Case

Any person presenting with a high fever (>39°C), with the appearance of jaundice in the conjunctiva and skin within 14 days of the appearance of the first symptoms in Koundara from October 1, 2020 to January 20, 2021 and in Kouroussa from October 1, 2020 to January 20, 2021.

Probable Case

Any suspected case with positive anti-yellow fever IgM antibody isolation in the absence of vaccination in the 30 days preceding the onset of the disease or with an epidemiological link with a confirmed case.

Confirmed Case

Any probable case with the detection by PCR of the yellow fever virus genome in the bloo

House Index (MI)

Percentage of houses infested with larvae and/or nymphs.

Container Index (RI)

Percentage of containers containing water infested with larvae.

Breteau Index (IB)

Number of positive containers per 100 houses inspected.

Household

All the occupants of the same dwelling without these people necessarily being united by family ties.

For the sample size calculation, we used Epi Info 7 software.

The accuracy parameter was set at 5%, the proportion at 50% and the margin of error α at 0.05.

The sample size of tuberculosis cases for our study is 618.

Sampling

This was an exhaustive sampling.

Data Collection Techniques and Tools

Interviews and observation were used as techniques, and the investigation form, case interview guide, rapid vaccination coverage monitoring form, close contact registration form, and larval home and environmental survey form were used as data collection tools depending on the target groups.

Probable Cases

An interview was conducted using the interview guide as a tool, the approach of which consisted of looking for risk factors and assessing the risks of transmission to other people (the places where they have stayed since the beginning of the illness).

Identification of Suspected Cases

An active search was conducted using active search forms in health facilities and in the community.

Within Healthcare Facilities: active case finding was conducted in consultation registers, laboratory records, and the surveillance log. Each new suspected case was recorded on an investigation form.

Within the Community: Active searches were conducted within a 400-meter radius of the Aedes mosquito's flight range around probable cases. Each new suspected case was recorded on an investigation form.

Rapid monitoring of vaccination coverage in VAA was done in households with people aged 11 months and over in the localities.

Entomological Survey

An entomological survey was conducted using larval survey forms for homes and the environment. The larval survey began at the forest edge, the boundary between the forest and human dwellings, around households, in water containers, discarded utensils, tires containing murky water, and murky ponds. All households in the targeted area were visited, and likely points of contact between the aedes and humans were identified and investigated.

Laboratory Procedures

Samples of 1-5 ml were taken from suspected cases of yellow fever and close contacts.

We allowed the clot to retract for 30-60 minutes at room temperature or centrifuged to separate the serum from the red blood cells, then aseptically poured the serum into sterile screw-cap tubes and stored between 4 and 8 °C. These serum samples were shipped in suitable packaging to prevent any breakage or leakage during transport and arrived at the laboratory within 02 days.

Data Entry and Analysis

The data from this investigation were entered and analyzed using Excel 2016 and Epi Info 7.2 software. Proportions, medians, and ranges were calculated. The results were presented in tables, figures, and a map.

Results

During the period from October 1, 2020 to January 20, 2021, 46 suspected cases of yellow fever were reported, including 3 probable cases and 14 deaths. The first case of illness began on November 6, 2020, with the number of cases increasing to a peak of 9 suspected cases on November 25, 2020 (Figure 3).

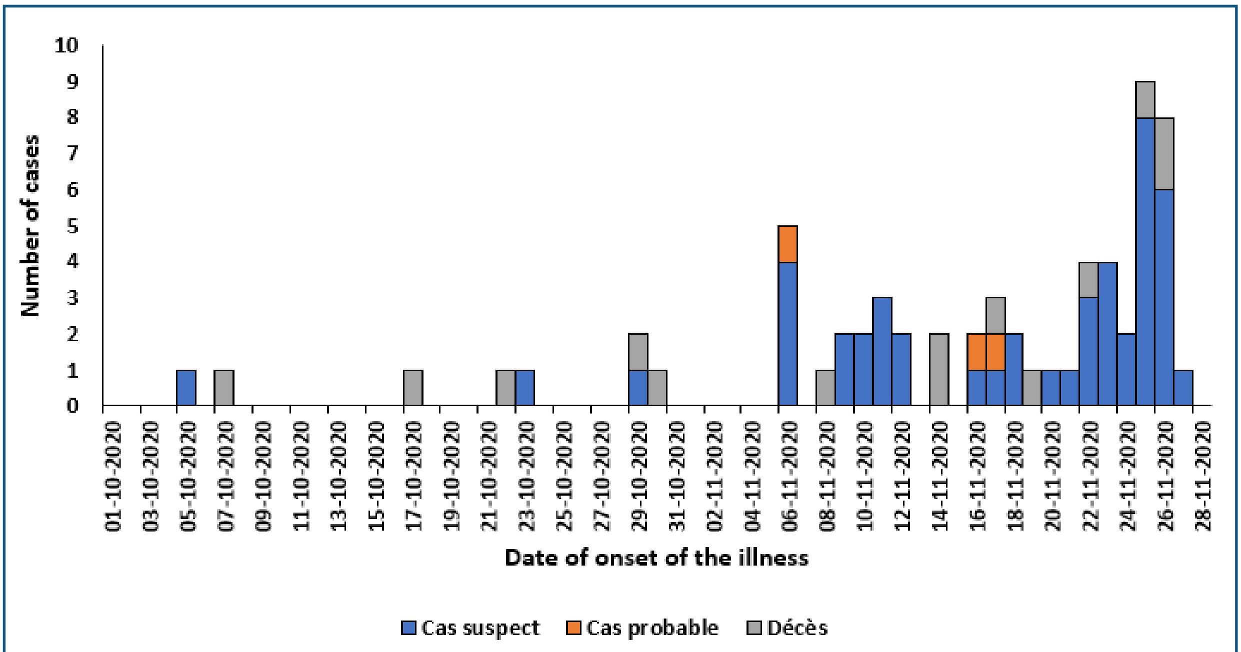

Figure 3: Evolution of probable and suspected cases of yellow fever in Koundara from October 1st to January 20th, 2021

From week 40 of 2020 to week S03 of 2021, 6 cases of yellow fever were identified through active case finding in health facilities (including one probable case and two suspected cases) and in the community (three suspected cases). The onset of illness in the first case was in week 44 (November 16, 2020) (Figure 4).

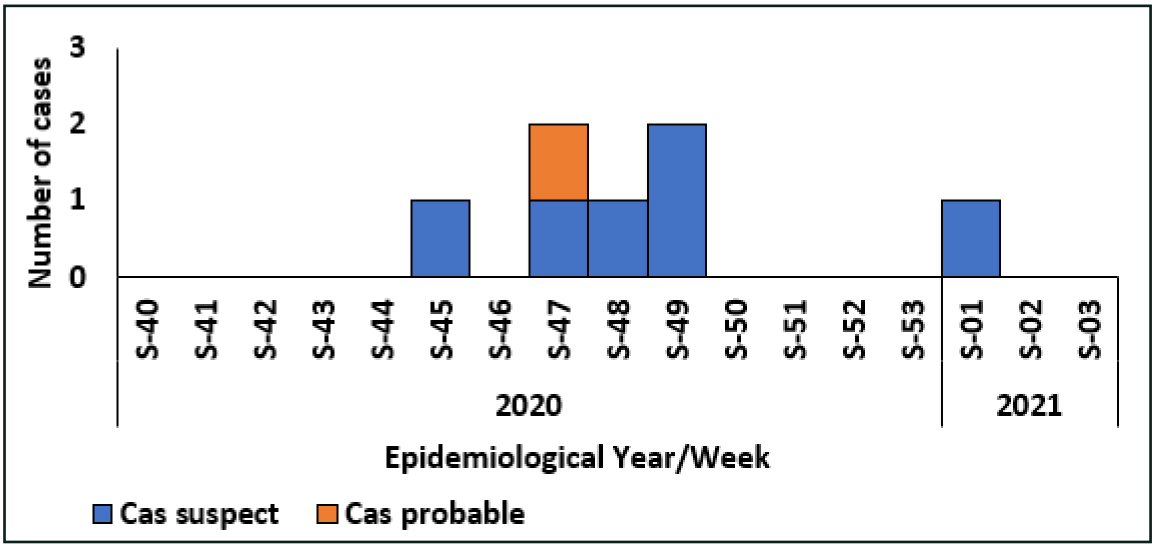

Figure 4: Evolution of probable and suspected cases of yellow fever in Kouroussa from October 1, 2020 to January 20, 2021

Table I : Sociodemographic Characteristics of Probable and Suspected Cases of Yellow Fever in Koundara and Kouroussa from October 1, 2020 to January 20, 2021

Features	**Koundara**	**Kouroussa**
Median age (extended)	3 years (0-16 years)	4 years (0-28 years)
Age	**n (%)**	**n (%)**
(5 years)	14 (28)	4 (67)
(5-15 years old)	29 (58)	0 (00)
(15 and over)	7 (14)	2 (33)
Male/female sex ratio	1-Jan	1-Jan
Sex		
M	34 (68)	3 (50)
F	16 (32)	3 (50)
Status vaccination		
Vaccinated	1 (02)	0 (0)
Unvaccinated		
31 (62)	5 (83)	
Unknown	18 (36)	1 (17)
Signs clinics		
Fever	45 (97)	6 (100)
Jaundice	37 (80)	6 (100)
Disorder of consciousness	23 (50)	0 (00)
Headaches	18 (39)	3 (50)
Nausea and vomiting	26 (57)	2 (33)
Vomiting with blood	19 (44)	0 (00)
Residence		
urban municipality	6 (13)	0 (00)
Sub- prefecture	40 (87)	6 (100)
From		
Alive	15 (33)	6 (100)

Deceased	14 (31)	0 (00)
Death status		
Hospital	09 (64)	0 (00)
Community	05 (36)	0 (00)

Table II: Situation of Suspects and Relatives Sampled and Tested in Koundara from October 1, 2020 to January 20, 2021

Concept	**Samples taken**	**Positive for IGM n (%)**	**Seroneutralization**
	n (%)		**n (%)**
Suspected cases	25 (78)	5 (20)	0 (00)
Close	7 (22)	0 (00)	0 (00)
Total	32 (100)	5 (16)	0 (00)

Table III: Situation of Suspects and Relatives Sampled and Tested in Kouroussa from October 1, 2020 to January 20, 2021

Concept	**Samples taken**	**Positive for IGM n (%)**	**Seroneutralization**
	n (%)		**n (%)**
Suspected cases	3 (16)	0 (00)	0 (00)
Close	16 (84)	0 (00)	0 (00)
Total	19 (100)	0 (00)	0 (00)

Vaccination coverage in the surveyed localities of Koundara and Kouroussa ranged from 1% to 42%. In contrast, routine vaccination coverage ranged from 41% to 88%.

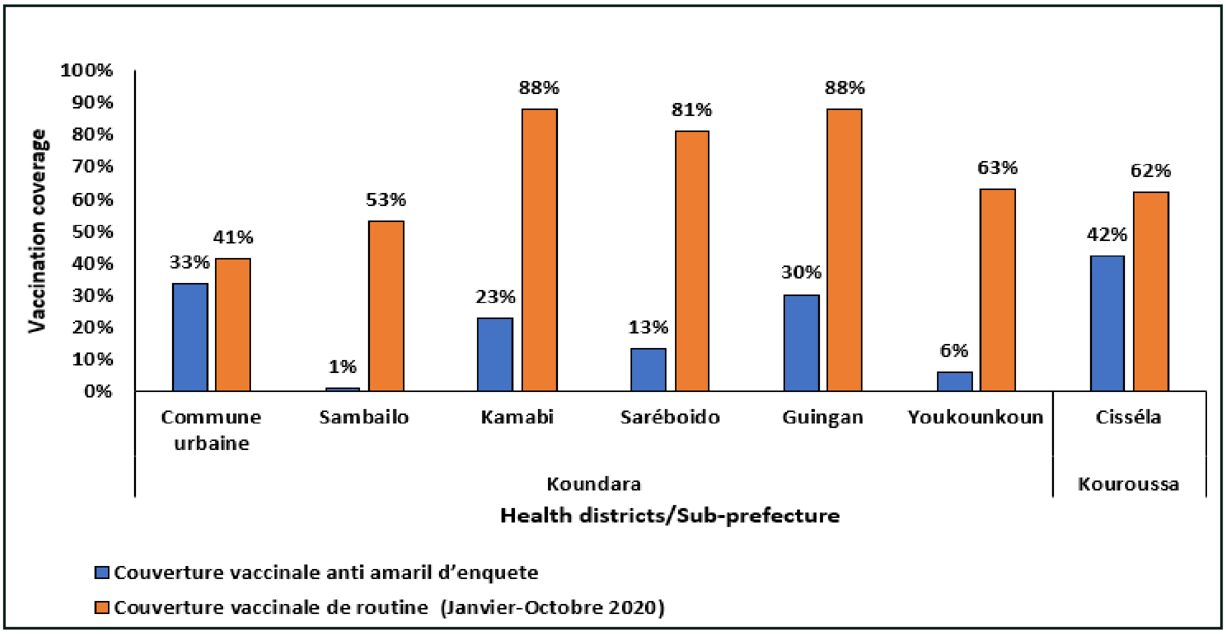

Figure 5: Yellow fever vaccination coverage in Koundara and Kouroussa from October 1, 2020 to January 20, 2021

In Koundara, among the larval breeding sites, 5 out of 13 contained Aedes larvae (positive) in the urban commune ; 3 out of 56 in Guingan ; 1 out of 7 in Kamaby and 5 out of 17 in Sareboido . Larvae of other disease vectors, notably Anopheles (in Kamaby) and Culex (in the urban commune of Koundara) were also identified.

At the level of human dwellings, 67 households were visited, of which 8 different potential larval habitats were encountered : poultry waterers (chickens and ducks), jerrycans, boxes, tires, jars, borehole (water collector), hollows and containers (Table IV).

In Kouroussa, the only water sources likely to serve as Aedes mosquito breeding sites were boreholes and outdoor toilets, but the breeding sites found there were often unsuitable and no larvae were discovered. In over 120 houses visited, no Aedes mosquito breeding sites were found inside, and no adults were visible. In Cissela -centre, the main town of the rural commune, the only larval habitat found was the tire on one of the two unimproved wells surveyed where only Culex larvae were found (Table IV).

Table IV: Distribution of Vector Larval Habitats found in Habitats by Locality in Koundara and Kouroussa from January 16 to 20, 2021

Sanitary district	Locality	Number of potential gîtes	Number of positive gites Ae	Number of positive gîtes per year	Number of positive gites Cx
Koundara	Municipality Urban	13	5	0	2
	Guingan	56	3	0	0
	Kamaby	7	1	1	0
	Sareboido	17	5	0	0
Kouroussa	Bambafara *	0	0	0	0
	Boussoura	0	0	0	0
	Cissela	2	0	0	10
	Fassoumaya	0	0	0	0
	Gnèmè	0	0	0	0
	Kalela banner	0	0	0	0
	Morigbeya -Saba**	0	0	0	0
	Nono	0	0	0	0
	Sokoro	0	0	0	0
	We are hungry.	0	0	0	0
	Toumourou	0	0	0	0

*: Village has Yellow Fever cases reported in 2019 **: Village Yellow fever cases notified in 2020
Ae : Aedes sp . An: Anopheles sp . Cx : Culex sp.

In Koundara, five types of sites frequented by patients from rural communities were explored: livestock camps, streams, ponds, puddles, and waterholes. These sites are used either for water supply or for livestock (watering troughs). Among these sites, 3 out of 5 visited had Aedes larvae in Guinga ; 4 out of 5 in Kamaby ; and none in Sareboido . A high number of larvae of other vectors were observed in the same sites, notably Anopheles and Culex (Table V).

In Kouroussa, a total of 15 breeding sites were surveyed in the physical environment of 10 localities (1 locality had no environmental breeding sites). In these sites, 45 Aedes sp . Larvae were found in 5 localities. Besides Aedes, other larvae (Anopheles sp . And Culex sp.) were also found, either alone or together, in the same surveyed breeding sites (Table V).

In Koundara, of all the localities and sites surveyed, all the Aedes larval breeding sites found were outside of houses. The risk factor assessment indices were the Bréteau index and the container index.

Table V: Distribution of Larval Habitats of Vectors Encountered in the Physical Environment by Locality in Koundara and Kouroussa from January 16 to 20, 2021

Sanitary district	Locations	Nbre de sites	Larves Ae	Larves	Larves
				An	Cx
Koundara	Guingan	5	4	19	22
	Kamaby	5	5	32	0
	Sareboido	2	0	16	2
Koundara	Bambafara *	2	5	0	10
	Boussoura	1	1	1	60
	Cissela	1	0	0	0
	Fassoumaya	1	0	0	0
	Gnèmè	2	2	2	3
	Kalela banished	1	0	0	0
	Morigbeya -Saba**	3	0	0	0
	Nono	2	33	8	0
	Sokoro	1	0	0	0
	Tidamadia	1	2	8	20

The distribution of these different larval habitats found around the dwellings and places of activity of yellow fever patients registered in the Koundara prefecture is given in the figure below (Figure 6).

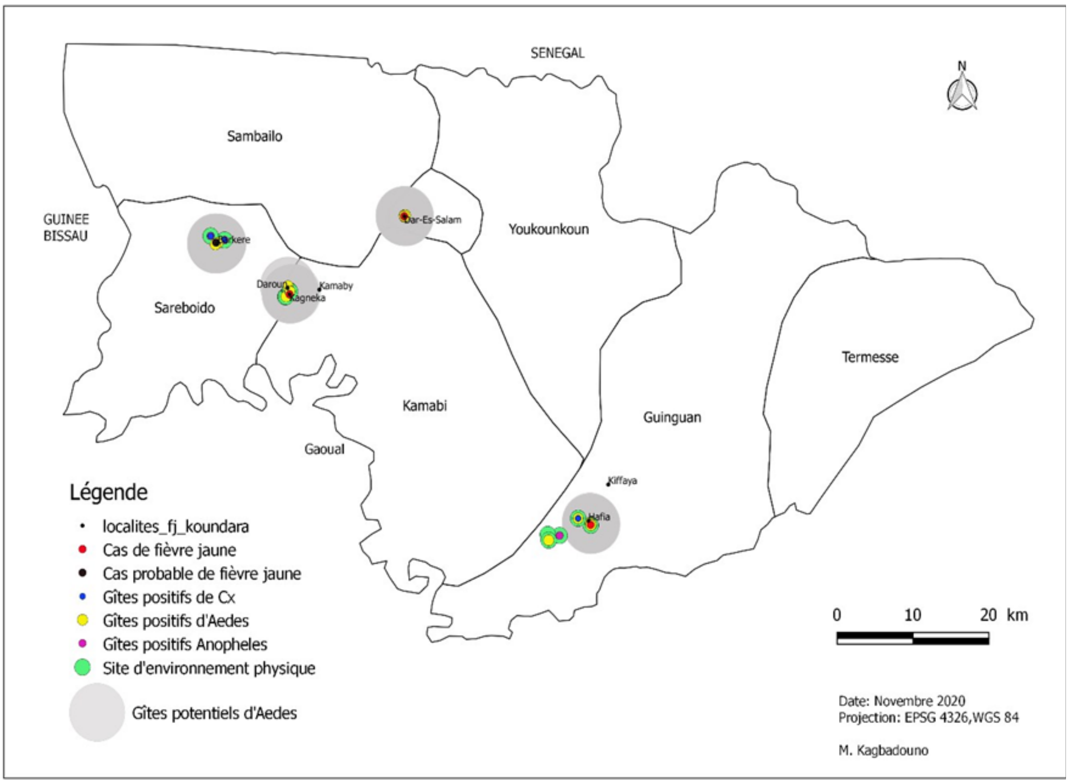

Figure 6 : Distribution of Aedes larval habitats encountered in the environment of yellow fever patients in Koundara from January 16 to 20, 2021

A map of these different larval habitats found in the localities concerned by this investigation is shown in the figure below (Figure 7).

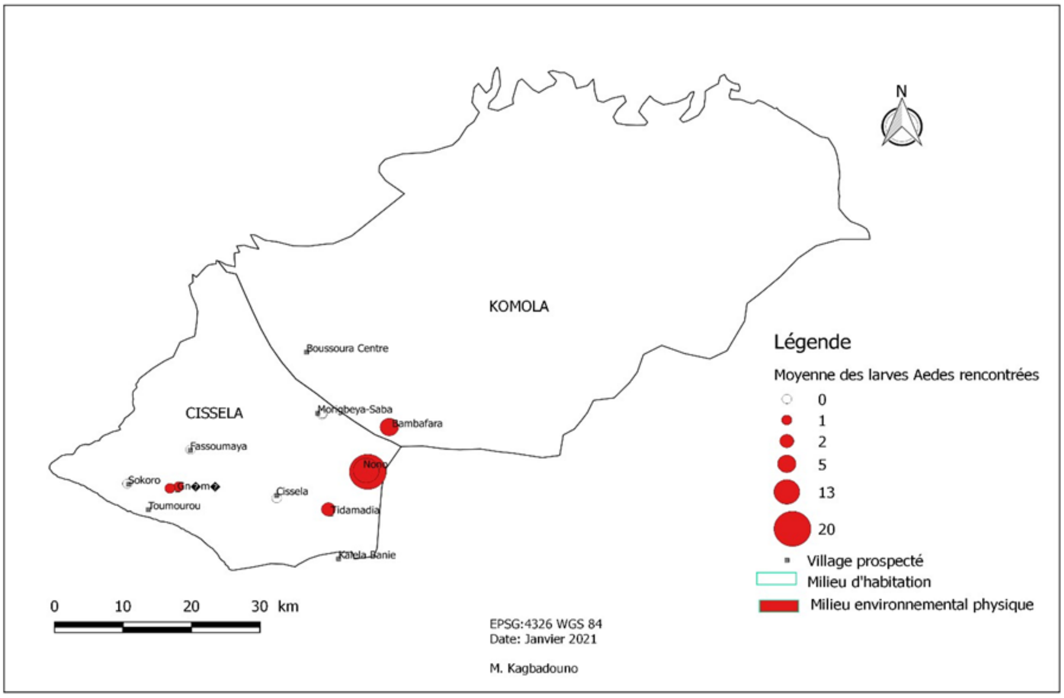

Figure 7: Distribution of potential breeding sites and average numbers of Aedes larvae encountered in Kouroussa from January 16 to 20, 2021

The highest container index was found in three localities within the urban commune: Kamaby and Sareboido ; while the Bréteau index values were higher in Guingan, an urban commune, and in Sareboido . There is a certain similarity between these two indices, such that a degree of correlation is observed between them. All the values observed here express a risk factor for transmission linked to changes in environmental conditions, both artificial and natural (Table VI).

In Kouroussa, in all the localities visited, the few and poor larval habitats found in human habitation areas showed no presence of Aedes larvae. All entomological indicators of epidemiological interest for yellow fever were zero (Table VI).

Table VI: Larval Index of Aedes Mosquitoes found in Koundara and Kouroussa from January 16 to 20, 2021

Sanitary district	Localities	Hint Home	Hint Container	Breteau Index
Koundara	Urban commune (Dar-Es-Salam)	Null	38	20
	Guingan (Madina) Hafia)	Zero	5	23
	Kamaby (Kagneka)	Zero	14	9
	Sareboido (Barkere)	Zero	29	17
Kouroussa	Cissela	Zero	Zero	Zero
	Boussoura	Zero	Zero	Zero
	Chisel	Zero	Zero	Zero
	Fassoumaya	Zero	Zero	Zero
	Gneme	Zero	Zero	Zero
	Calculate wife	Zero	Zero	Zero
	Morigbeya-cause	Zero	Zero	Zero
	Nono	Zero	Zero	Zero
	Socorro	Zero	Nul	Nul
	Tidamadia	Nul	Nul	Nul
	Toumourou	Nul	Nul	Nul
	Komola	Nul	Nul	Nul
	Bambafara	Nul	Nul	Nul

Discussion

The epidemiological investigation revealed that the visited localities of Koundara were the most affected, with eight (8) probable cases, including fourteen (14) deaths, representing a case fatality rate of 31%. Our results are similar to those of Yao Lucien Konan et al. in Côte d'Ivoire (16 cases, including eight deaths, representing a case fatality rate of 50%) [2]. This high rate could be explained by the reluctance of some parents to send sick children to the CT-Epi (Center for Epidemic Treatment) in a timely manner for better care, using the pretext that they cannot afford food in the city.

Unfortunately, the surveyed areas in Koundara and Kouroussa were not well covered, with an average vaccination rate of only 40% against yellow fever. The fact that almost all cases were in children under 15 years old suggests transmission around homes, and also in streams with relatives or in areas near forests, facilitated by sylvatic vectors. Analysis of these two shared environments (human-vector) reveals a relatively behavioral exposure. The areas surrounding homes are often children's favorite recreational spaces, with these areas serving as play areas. This situation would explain the high risk in this age group.

According to WHO data [5], the index values collected during this survey indicate a risk of yellow fever epidemics in all visited localities (≥5) in Koundara. This risk has two epidemic levels: a high risk in the urban commune of Koundara and the rural commune of Guingan (IB 20 to 50) and a low risk in the rural communes of Sareboido and Kamaby (IB <20). In both localities, despite the low index values observed, the combination of ecological factors in the identified breeding sites could contribute to a change in the situation over time. This eco-epidemiological status would lead to epidemics that are often deadly.

In the human habitation zone, almost all the larval breeding sites identified during this survey were outside houses, indicating that the Aedes mosquito encountered in Koundara is primarily a peri-urban species. This behavior is similar to what was observed in a study in Cameroon [16]. In this case, a decrease in entomological and epidemiological indicators could be observed with the onset of drought affecting the breeding sites. This would explain the occurrence of epidemic episodes at the beginning of the dry season observed in this region.

In Kouroussa, almost all potential larval breeding sites were found in the physical environment. However, it is worth noting the absence of potential breeding sites for Aedes mosquitoes inside houses in both outbreak areas (Koundara and Kouroussa), which would reflect the same community practices contributing to a reduction in the risk of yellow fever transmission within homes.

However, the cycle is conditioned by an "emergence zone" that covers the boundaries of biotopes (dry savannah, gallery forests around water sources). In this case, the virus could circulate continuously and silently thanks to the presence of monkeys and the dual "vector/reservoir" role of the Aedes mosquito, which is nourished by vertical transmission [5,17]. Agro-pastoral activities bringing humans to this ecosystem and the active nature of these vectors (especially since breeding sites are located near villages) could lead to human transmission causing intermediate -type epidemics [2,9].

The fauna collected at Koundara and Kouroussa also included Anopheles and Culex larvae, most often found in muddy water near a borehole, similar to the study by A. Rickenbach et al. in Cameroon and Taufflied et al. in Senegal [2,18]. This co-occurrence could suggest a possible co-infection among yellow fever cases with other diseases transmitted by these vectors.

The vector's remarkable dispersal capacity and the dynamics of human and monkey populations in these areas would present a risk of outbreaks shifting and disease spreading.

Conclusion

Our investigation shows that the possible existence of the yellow fever epidemic in the surveyed areas is of an intermediate type and is conditioned by a rural cycle. A survey vaccination coverage of 20% and Recipient and Breteau indices ≥ 20 in Koundara and that of Kouroussa is 42% and the larval indices are zero.

All cases tested in Koundara and Kouroussa were found to be negative by seroneutralization . Therefore, human-to-human transmission of yellow fever is virtually nonexistent.forested character, its eco-epidemiological implications are concerning due to the presence and persistence of the virus. The aim will be to determine the pattern of transmission from one area to another through a study of vector populations and migrating wild reservoirs.

Business Actions

- Organising a response in all localities where there have been cases and those in neighbouring areas.
- Widespread awareness-raising among populations for lasting behavioral change regarding risk factors for yellow fever transmission.

Recommendations

At the conclusion of this investigation, we recommend:

- Strengthen epidemiological surveillance at all levels ;
- Involve environmental services in the management and prevention of the yellow fever epidemic ;
- Introduce entomological surveillance of yellow fever and other arboviruses in Guinea in the strategic plan for the surveillance of diseases with epidemic potential ;
- Organize an entomological survey at the end of the rainy season to better understand the risk transition mechanisms ;
- Consider vector population studies and potential reservoirs.

Consent

Verbal informed consent was obtained from each person interviewed.

Ethical Approval

The study protocol was approved by the approval committee of the Faculty of Health Sciences and Techniques of Gamal Abdel Nasser University of Conakry.

The anonymity and confidentiality of the participants were respected.

Disclaimer (Artificial Intelligence)

No generative AI technology such as large language models (ChatGPT, COPILOT, etc.) and text-image generators was used in the writing of this manuscript.

Conflict of Interest

The authors stated that there were no competing interests.

Illustrative Images

Rencontre avec les autorités locales et sensibilisation dans les localités

Enquête entomologique dans le milieu environnemental

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